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Analysis on Design Sensitivity of Permanent Magnet Motor using Lumped Magnetic Circuit Method

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In general, Spoke type Permanent Magnet Synchronous Motor (PMSM) has intense air gap flux density due to its magnet arrangement. However, variation of machine performance is severe due to its design variables, such as air-gap length and magnet size. On the other hand, Surface Mounted PMSM (SPMSM) is less sensitive to change of variables that are mentioned above. In this study, we examine the air-gap flux density of SPMSM and Spoke type PMSM with respect to air-gap length and magnet size, in order to identify the sensitivity of performance. It is analyzed numerically based on magnetic equivalent circuit (MEC) method and it is validated through the comparison with FEA results. While establishing MEC, magnetic reluctance, which has different flux path, is considered as component of equivalent circuit element and is defined numerically. For simplicity of the analytical model, magnetic saturation in the rotor and stator cores are ignored, allowing magnetic reluctance of core to be neglected. Thus MEC is composed of air-gap and magnet magnetic reluctance which has low magnetic permeability, and air-gap flux density is calculated numerically in respect to fluctuation of these variables

Considering that air gap flux density of Spoke type motor is varies sensitively to air gap length fluctuation, calculation and analysis is carried out by altering air-gap length from 0.5 mm to 1.5mm with increment of 0.1mm. Moreover, change in air gap flux density considering variation of magnet width is from -1.5 mm to 1.5mm with increment of 0.1mm.

These two types of motor are designed with equivalent condition. In addition, sensitivity of air-gap length and magnet size are compared through both MEC and FEA. As sensitivity of motor can be predicted using MEC, the issue could be avoided in preliminary design stage.

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